375-3789

May 27, 1998

Mr. George Hunton
Governor's Office of Energy and Community Services
57 Regional Drive, Suite 3
Concord, NH 03301-8519

Dear Mr. Hunton:

As you requested, enclosed is a cost/benefit analysis that gives the impacts resulting from adopting the 1995 Model Energy Code (MEC) compared to the current New Hampshire residential energy code. The costs and benefits are for a typical single-family house built in Concord.

Based on our analysis, complying with the MEC requirements instead of the less stringent New Hampshire requirements should save consumers money. The estimated first-cost increases are about $270 (if the basement is heated) and $560 (if the basement is unheated) for the two-story cape house examined here. A mortgage spreads most of this cost into the future. Home buyers should first realize a cumulative net savings (accounting for all costs including the down payment) in about 1 to 3 years (for a 10% down payment). Net savings vary from $11 to $45 a year. The cost impacts are based on comparing the minimum code levels. In reality, many New Hampshire homes exceed the current state code and already meet most if not all of the requirements of the MEC.

Attachment A provides more detailed cost impact information. Attachment B provides information on the assumptions and methodology used in the analysis to determine the cost impacts.

The adoption of a new energy code in New Hampshire, including the specifics of that code, is a decision to be made in New Hampshire. This information is not meant to imply that the Energy Policy Act of 1992, Pacific Northwest National Laboratory (PNNL), the U.S. Department of Energy (DOE), or I can or should dictate New Hampshire's decision on a building energy code.

Please feel free to call me if you have any questions.

Sincerely,

Robert Lucas
Building Standards and Guidelines Program

cc: Craig Conner, PNNL
Margo Appel, DOE
Stephen Turchen, DOE
Sam Thomas, DOE/BRSO
File/LB

ATTACHMENT A

ECONOMIC IMPACTS OF 1995 MODEL ENERGY CODE IN NEW HAMPSHIRE

May 27, 1998

This attachment provides the incremental economic impacts resulting from compliance with the 1995 Model Energy Code (MEC) (CABO 1995) (as referenced in the 1996 *BOCA National Building Code*) requirements instead of the less stringent New Hampshire code on typical single-family home buyers. These impacts include the increase in the cost of the house, mortgage-related costs, energy cost savings, net annual cost savings, and the time to cumulative positive cash flow. This analysis illustrates the impacts of the MEC requirements on a typical house in Concord--a 1944 ft^2 two-story house with a basement (both heated and unheated basements are examined) and 264 ft^2 of window area. Information on the input parameters for the analysis is given in Attachment B.

First Costs

The first costs are the incremental retail costs to purchase and install energy efficiency features in the house; for example, the cost to buy and install more insulation. These costs include the builder's profit and represent the amount paid by the home buyer if the buyer pays for the house in cash.

Table 1 shows the cost increases for construction changes needed to comply with the 1995 MEC requirements. This table shows the total cost increase and the individual envelope component cost increases for heated and unheated basements. The New Hampshire code is more stringent than the MEC for basement wall insulation, so the cost increase is negative. Note that other combinations of improvements in energy efficiency measures exist that comply with the 1995 MEC. For example, if a more efficient natural gas furnace is installed (an 80%-efficient oil boiler is assumed here--the lowest efficiency allowed by law), insulation levels may be lowered somewhat. Actual construction cost increases related to MEC compliance will often be considerably lower because many new homes exceed some of the requirements in the current state code. In fact, as shown in Attachment B, typical construction practice in new homes in New Hampshire normally meets the basic requirements of the MEC. Also see Attachment B for details on the assumed combinations of energy efficiency measures, cost data sources, and other assumptions.

Table 1. First-Cost Increases Per Housing Unit from MEC Compliance

	Total Cost	Windows	Ceiling Insulation	Basement Wall Insulation	Basement Ceiling Insulation
NH Code to 1995 MEC					
Unheated Basement	$562	$280	$151	--	$131
Heated Basement	$272	$280	$151	-$159	--

Mortgage-Related Cost Impacts

Because most houses are financed, the financial impacts of the 1995 MEC requirements on mortgages will likely be of significant interest to the consumer. Mortgages spread the payment for the cost of a house over a long period of time. In this analysis, a fixed-rate mortgage is assumed and the interest portion of the payments is assumed to be deducted from income taxes.

Table 2 shows how mortgage-related costs will be impacted for a 30-year fixed-rate mortgage with a 10% down payment. The down payment costs include the down payment, points, and loan fees. The savings from income tax deductions for the mortgage interest will slowly decrease over time, and the values shown in Table 2 are for the first year. Table 2 includes increases in annual property taxes because of the higher assessed house value.

Table 2. First-Year Mortgage Cost Increases Resulting from Increased Energy Efficiency

	Cost Increase Per Housing Unit
Annual mortgage payment increase	
Unheated basement	$42
Heated basement	$20
Down payment[a] cost increase	
Unheated basement	$63
Heated basement	$30
First-year tax deduction savings	
Unheated basement	$8
Heated basement	$4
Property tax increase	
Unheated basement	$16
Heated basement	$8

(a) Includes points and loan fees.

Energy Cost Savings

The 1995 MEC will result in a reduction in energy costs (i.e., the homeowner's utility bill for heating and cooling) because the house is more energy-efficient than the same house built to meet the current New Hampshire code.

Table 3 shows the estimated annual energy cost savings from the increased level of energy efficiency required by the MEC.

Table 3. Annual Energy Cost Savings from MEC Compliance

	Cost Savings Per Housing Unit
Unheated Basement	$95
Heated Basement	$35

Note that the annual energy cost savings in Table 3 are for current fuel prices. If energy costs increase in the future, the energy cost savings will increase as well.

Net Annual Cost Savings

Table 4 shows the net annual cost savings, including energy costs, mortgage payments, mortgage tax deductions, and property taxes but not the up-front (down payment, points, and fees) costs.

Table 4. Net Annual Cost Savings from MEC Compliance

	Cost Savings Per Housing Unit
Unheated Basement	$45
Heated Basement	$11

Time to Cumulative Positive Cash Flow

Most consumers want to know when they will start saving money (accounting for all costs and benefits). The energy cost savings resulting from increased energy efficiency start as soon as the dwelling is occupied. Of more interest may be the time when homeowners will have saved more money than they have paid out (including the down payment), referred to as the time to cumulative positive cash flow. Beyond this time, the net cost savings can be expected to continue to grow; thus, the shorter the length of time to positive cash flow, the more attractive investing in increased energy efficiency becomes.

Table 5 shows the number of years until the homeowner is expected to realize a net cost savings from increased levels of energy efficiency (i.e., the cumulative savings exceed the cumulative expenditures). This length of time was derived from calculations using up-front costs, mortgage payments, energy costs, property taxes, and mortgage interest tax deductions. For example, during the second year of ownership, a homeowner with a unheated basement would save more money than expended and the savings would continue to grow after that time.

Table 5. Years to Positive Cash Flow

Unheated Basement	1 1/2 years
Heated Basement	3 years

Summary

The MEC has more stringent requirements than the New Hampshire code for roof/ceilings, floors above basements, and above-grade walls. The New Hampshire code has more stringent requirements for basement walls (if the basement is heated). This analysis indicates that homes built to meet the MEC requirements will save New Hampshire homeowners money by reducing energy costs by more than the construction-related cost increases. Homeowners should realize a net positive cash flow in about one to three years after accounting for the effects of a typical mortgage. Because newly-built New Hampshire houses often exceed the minimum state code requirements and in fact already meet the MEC, construction cost increases and energy cost savings should be smaller than those shown here, and may often be zero. Construction cost increases and energy savings will vary depending on many factors, including location, fuel prices, house characteristics, construction costs, and the energy efficiency measures used to comply with the MEC.

References

Council of American Building Officials (CABO). 1995. *Model Energy Code; 1995 Edition*. Falls Church, Virginia.

ATTACHMENT B

ASSUMPTIONS USED IN ANALYSIS OF THE MODEL ENERGY CODE IN NEW HAMPSHIRE

May 27, 1998

Financial and Economic Assumptions

The financial and economic parameters required for input to this analysis are summarized below. These parameters are used to calculate the costs and benefits of increased energy efficiency from the homeowner's perspective. A relatively low down payment and low federal income tax rate were selected to better represent lower-income home buyers.

- new-home mortgage parameters
  - 7.0% mortgage interest rate (fixed rate)
  - points and loan fees equal to 1.6% of the mortgage amount
  - 30-year loan term
  - 10% down payment

- other rates and economic parameters
  - 15% marginal federal income tax
  - 2.8% property tax.

- fuel prices
  - heating oil price of 85 cents/gallon.

Complying Measures for the New Hampshire code and the 1995 Model Energy Code

This economic analysis considers the cost effectiveness of thermal-envelope requirements and heating and cooling equipment. The envelope components considered in the analysis are ceilings, above-grade opaque walls, windows, doors, and basements with wall or ceiling insulation. Table 1 shows insulation levels and window types assumed in this analysis for the current New Hampshire state code and 1995 Model Energy Code (MEC) (CABO 1995) compliance for the single-family house described below. The measures used for MEC compliance shown in Table 1 were selected to match the MEC's individual envelope requirements. These were obtained using the MEC*check*™ software, which notifies the user if a set of insulation levels, window measures, and heating and cooling efficiencies complies with the MEC and allows tradeoffs across all building components (DOE 1995).

Many recently built New Hampshire houses exceed the minimum requirements of the current state code. It is interesting to compare the requirements of the MEC to "typical" current practice. To compare the energy codes to actual New Hampshire homes, we obtained energy-efficiency related current practice data and determined the typical level of energy efficiency in recently-built homes. The most common insulation levels were obtained from the National Association of Home Builders' (NAHB) Builder Practices Report (NAHB 1997). The oil boiler efficiency of 84% is estimated from the distribution of available equipment based on the Gas Appliance Manufacturers Association

Table 1. Insulation Levels and Window Types Used for Compliance

	Ceiling Insulation	Wall Insulation	Window Type	Basement Insulation	Boiler Efficiency
State code	R-30	R-19 batt	Double wood, U-value of 0.55	R-19 wall or R-11 ceiling[a]	80% AFUE
Current practice	R-34	R-19 batt	U-value of 0.40	R-19 wall or R-11 ceiling[a]	84% AFUE
1995 MEC	R-38	R-19 batt	Double wood with low-E, U-value of 0.38	R-11 wall or R-19 ceiling[a]	80% AFUE
(a) Basement wall insulation is assumed for heated basements. Basement ceiling insulation is assumed for unheated basements.					

(GAMA) equipment directory (GAMA 1996). Table 1 shows the measures that are the most common in current practice. When the typical current practice measures are input into MEC*check*™, the house examined here complies with the 1995 MEC for both heated and unheated basements. Therefore, this illustrates one alternative method of complying with the MEC.

The MEC also contains a number of other requirements, including insulation for pipes and ducts, installing a vapor barrier, sealing leakage points in the envelope, and NFRC ratings for windows. The impacts of these miscellaneous requirements are not included in this analysis.

Heating Fuel Type, Fuel Cost, and Equipment Efficiency

An oil boiler with an annual fuel utilization efficiency at the federal minimum (80%) was assumed in the analysis. An oil price of 85 cents/gallon was assumed. The house was assumed to not have air conditioning.

Cost Data

The analysis used to determine the cost effectiveness of adopting the 1995 MEC in New Hampshire requires information on cost increases in insulation and window measures needed to meet the 1995 MEC requirements instead of the current code requirements. Insulation cost data were obtained from *Means Residential Cost Data--1998* (Means 1997). See Attachment A, Table 1, for the specific insulation upgrade costs used in this analysis.

The cost of low-E coatings on double-pane windows was estimated to be \$0.75/ft^2. This cost is supported by a recent survey in Ohio that reported a cost of \$0.65/ft^2 to improve windows from a U-value of about 0.50 to below 0.35 (Ohio 1996). Wood windows (or vinyl windows) without low-E are assumed to have a U-value of 0.50. The addition of low-E is assumed to improve this U-value to 0.38. Costs for the 0.55 U-value windows (NH code requirement) was determined using linear extrapolation of the \$0.75 cost. See Attachment A, Table 1, for the window upgrade costs used in this analysis.

Prototype Dimensions

A two-story, single-family cape house with a conditioned above-grade floor area of 1944 ft^2 was assumed in this analysis. For the heated basement scenario, the basement adds an extra 936 ft^2 of conditioned living space. Other dimension assumptions were 8-ft-high ceilings; a ceiling area (bordering the unconditioned attic) of 1008 ft^2; a gross exterior above-grade wall area of 2016 ft^2; a basement ceiling area of 936 ft^2; and a basement wall area of 992 ft^2. A window area of 264 ft^2 (13.1% of the wall area) and a door area of 20 ft^2 were assumed. These dimensions were obtained from an actual house built recently in New Hampshire, and represent a very common type of house according to the New Hampshire Office of Energy and Community Services.

Two types of basements were analyzed. The first is a heated basement with wall insulation. The second is an unheated basement with basement ceiling insulation. Our current practice data indicates unheated basements are more prevalent in upper New England, though heated, walk-out basements are not uncommon.

Analysis Tool

The energy database in the Automated Residential Energy Standard (ARES) program was used in the analysis. The ARES software was developed for DOE and contains an economic methodology for residential energy efficiency decisions (Lortz and Taylor 1989). Given a set of fuel-price, financial, economic, and energy efficiency measure cost parameters for a building at a specific location, ARES identifies the economic impacts of incremental improvements in energy efficiency. ARES considers both space heating and cooling and is designed specifically for residential energy efficiency analyses.

In addition to an economic analysis model, ARES incorporates an energy database produced by a simulation model, allowing it to estimate the energy use for a specific selection of insulation and window measures. The energy usage associated with each combination of measures becomes an input to the ARES economic analysis. The ARES energy simulation is a parameterization of a large database of DOE-2 simulations (DOE-2 is a sophisticated energy analysis software commonly used to estimate building energy consumption) (DOE 1989).

The ARES program can evaluate the benefits of foundation insulation in homes with unheated basements, but more comprehensive data on foundation heat loss are available in the *Building Foundation Design Handbook* (Labs et al. 1988). Therefore, this source was used for the energy usage portion of the analysis of basement insulation.

References

Council of American Building Officials (CABO). 1995. *Model Energy Code; 1995 Edition*. Falls Church, Virginia.

Gas Appliance Manufacturers Association (GAMA). 1996. *Consumers' Directory of Certified Efficiency Ratings*. Arlington, Virginia.

Labs, K., J. Carmody, R. Sterling, L. Shen, Y. J. Huang, and D. Parker. 1988. *Building Foundation Design Handbook*. ORNL/Sub--86-72143/1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Lortz, V. B., and Z. T. Taylor. 1989. *Recommendations for Energy Conservation Standards for New Residential Buildings - Volume 2: Automated Residential Energy Standard -- User's Guide - Version 1.1*. PNL-6878, Vol. 2, Pacific Northwest Laboratory, Richland, Washington.

National Association of Home Builders (NAHB) Research Center. 1997. *Builder Practices Report--Insulation Usage in New Home Construction--1996*. Upper Marlboro, Maryland.

Ohio Department of Development (Ohio). 1996. *Standard Building Practice Among Ohio Builders and Changes Necessary to Comply with the Council of American Building Officials' Model Energy Code 1993 Version*. Columbus, Ohio.

R. S. Means Company, Inc. (Means). 1997. *Means Residential Cost Data--1998, 15th Annual Edition*. Kingston, Massachusetts.

U.S. Department of Energy (DOE). 1989. *Technical Support Documentation for the Automated Residential Energy Standards (ARES) - In Support of Proposed Interim Energy Conservation Voluntary Performance Standards for New Non-Federal Residential Buildings*. DOE/CE-0274, Vol. 4, Washington, D.C.

U.S. Department of Energy (DOE). 1995. *1995 MECcheck™ Manual, 1992 Model Energy Code Compliance Guide, Version 2.0*. Building Standards and Guidelines Program, Pacific Northwest National Laboratory, Richland, Washington.